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USING ARM TWP NAURU OBSERVATIONS TO EVALUATE A SIMPLE THERMODYNAMIC MODEL OF THE SUBCLOUD LAYER UNDER FAIR-WEATHER CUMULUS CONDITIONS

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ABSTRACT

Marine boundary layer clouds are fundamental in regulating the vertical structure of water vapor and entropy in the lowest 2 km of the Earth's atmosphere. The observations from the ARM TWP-Nauru site provide a unique opportunity to study these clouds and the associated boundary layer structure. In this study an atmospheric mixed layer representation of the subcloud layer for application in fair-weather cumulus regimes is used to develop a diagnostic model of the near surface temperature and moisture associated with a given surface temperature and wind speed. This model assumes local steady state (radiative-convective) equilibrium, cloud base height (mixed layer depth) fixed at the mixed layer LCL, and a linear relationship between subcloud layer longwave cooling and fractional cloudiness. This model is evaluated using 4.5 years of data (Jan 99- Jun 03) from the Nauru ARM site using cloud properties from the ARSCL VAP, temperature and moisture soundings, and meteorological and radiation data at the surface. A climatology of nighttime boundary layer clouds is developed using the ARSCL cloud properties data sets. A comparison of the observed cloud base height with the LCL calculated from the surface meteorological data is used to evaluate the major simplifying assumption of the model. The relationship between fractional cloudiness and the surface downward longwave flux is established using hourly averaged values. The full subcloud layer model is evaluated using sea surface temperatures upwind of the site obtained from satellite retrievals and the wind speed and fractional cloudiness measured at the site as input. The magnitudes of the advective terms in the temperature and moisture budgets are estimated using NCEP reanalyses. Model predicted near surface temperature and moistures values are then compared with those observed.